



Evolving Advanced Traffic Surveillance Prototype Avionics towards Products

NASA ICNS Conference
20 May 2003

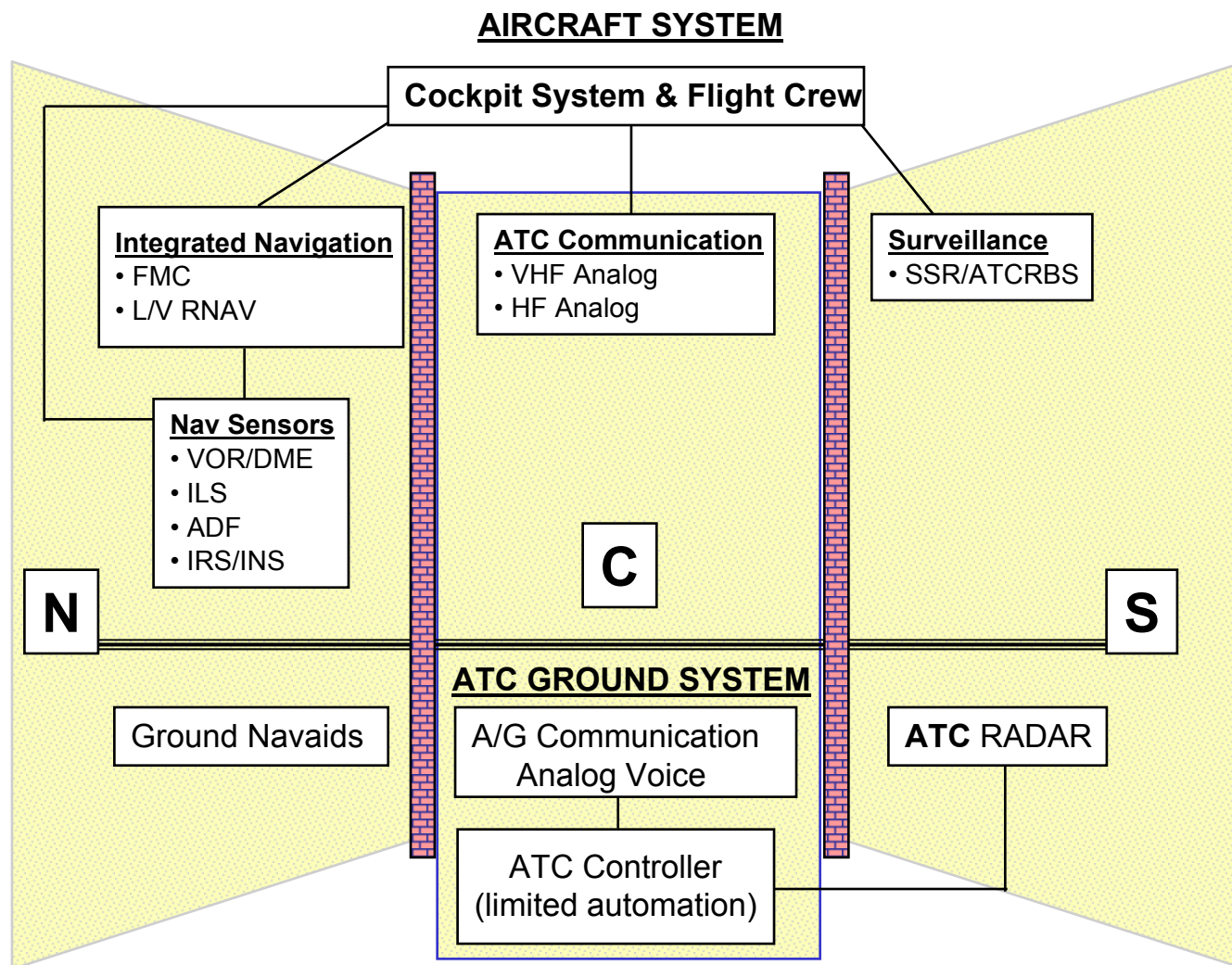
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Overview

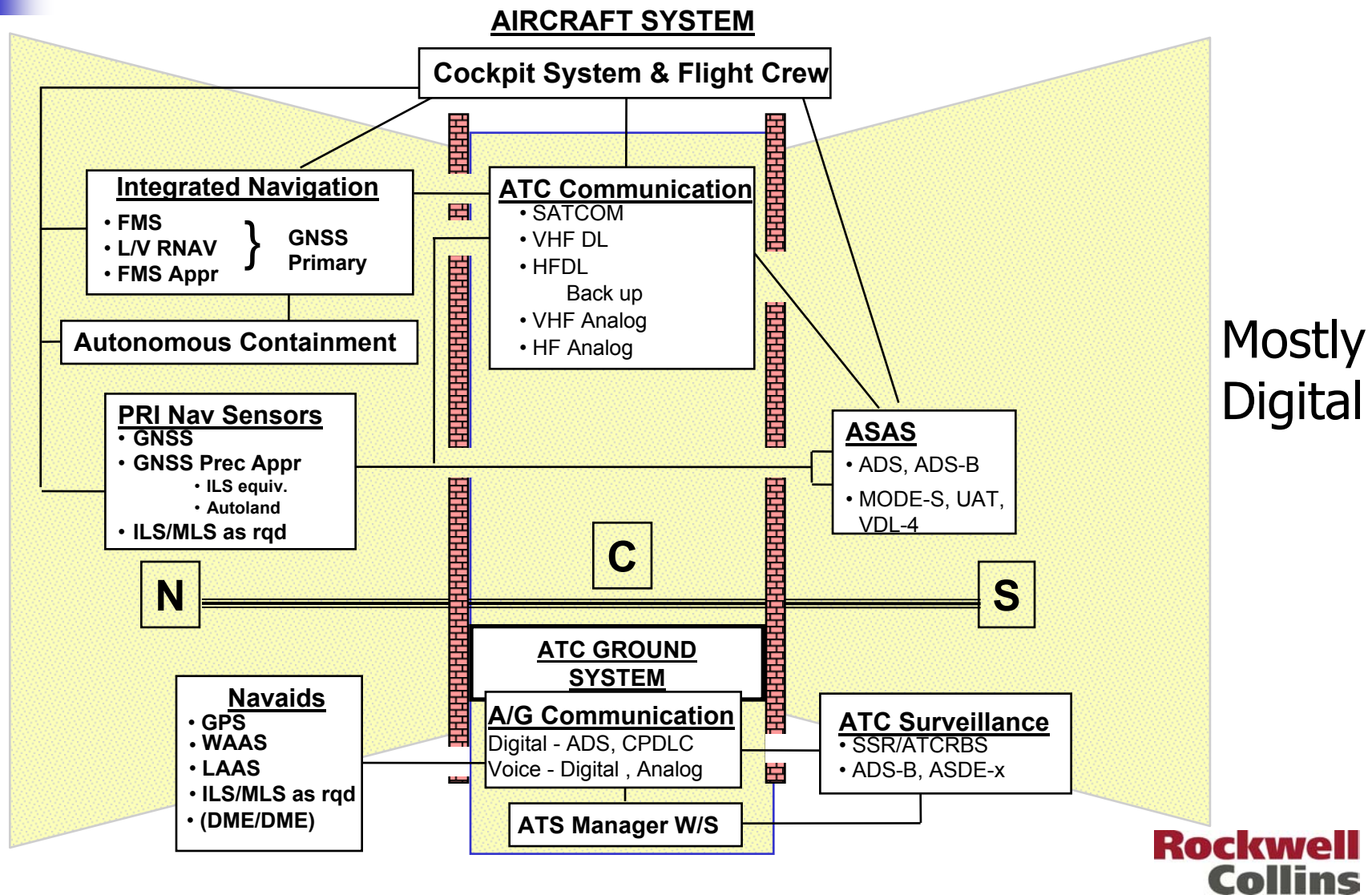
- **Focus of presentation**
 - **Avionics prototypes** relating to Air Transport Aircraft in the USA
 - **ADS-B Avionics**
 - Transmitters
 - Receivers (Processors)
 - **Displays**
 - Cockpit Display of Traffic Information (CDTI) Display
 - Airport Surface Moving Map Function
 - **Recognize other activity**
 - Business and Regional Aircraft
 - Smaller G/A Aircraft
 - European Activities
 - NEAN, NUP, NUP-2, Package-1 (2007)
 - Australian Activities
 - ADS-B ground station, trials, possible mandate for ADS-B out
 - **Status and plan**

The Legacy CNS Systems



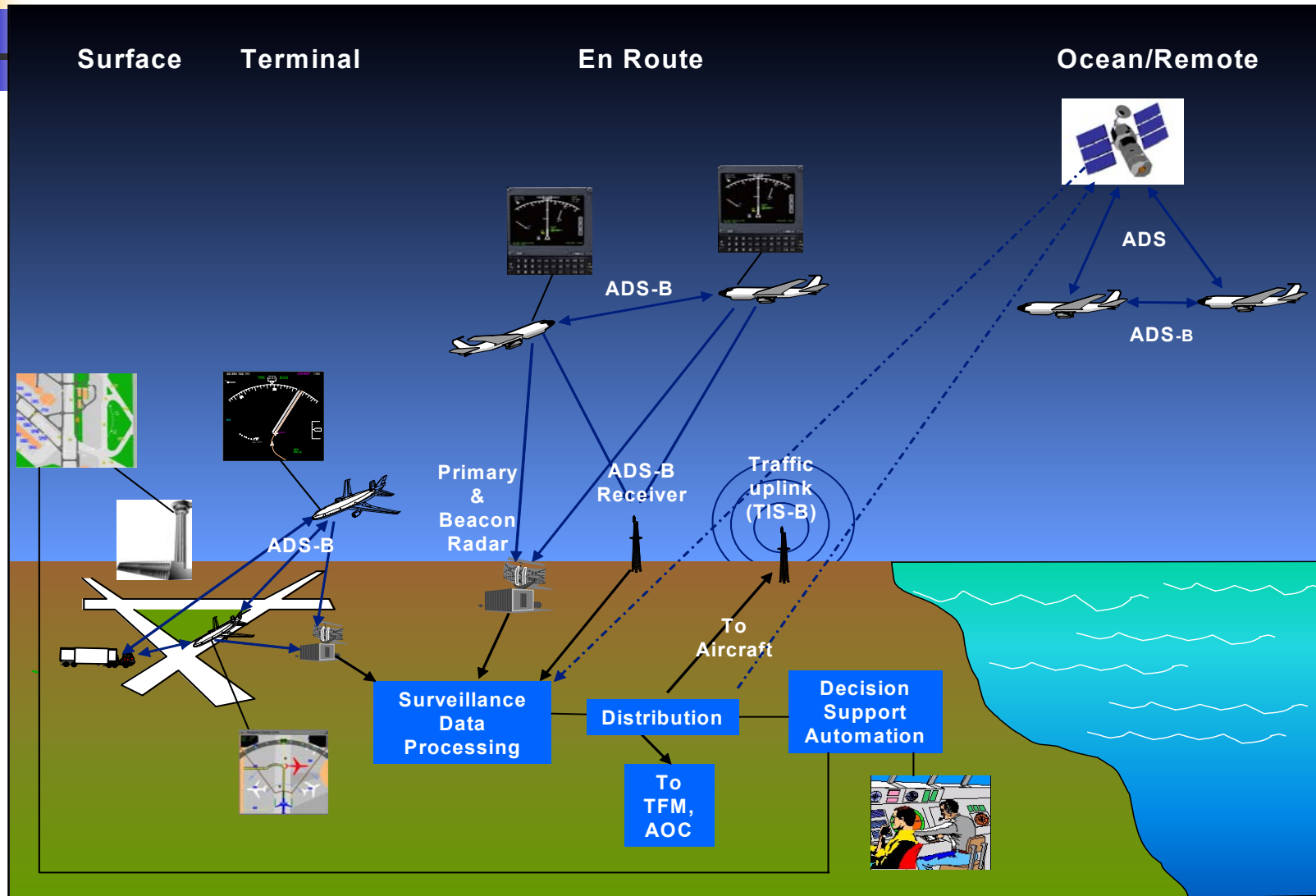
Mostly
Analog

The ICNS Systems



Advanced Traffic Surveillance & Separation Assurance Solutions

Efficiency / Safety Applications for all Phases of Flight





Traffic Surveillance Methods

- “Old” Methods
 - Radar
 - Primary Surveillance Radar (PSR)
 - Secondary Surveillance Radar (SSR)
 - Airport Surface Detection Equipment (ASDE-3) [PSR]
- “Advanced” Methods
 - ADS-B (also ADS-A/C)
 - TIS-B
 - Multilateration, ASDE-X
- Other Surveillance Related Technologies
 - Precise, object based airport surface maps

Aircraft as object of control → Aircraft as part of airspace

Advanced Surveillance Transitions

- Need Platform Architecture for Functional Implementation
 - XPDR/TCAS/New LRU
 - Air to Air ADS-B Functionality Implemented
- First Significant aircraft architectural changes
- Certification Challenges Increase
- Includes TIS-B

Process Data (Separation Assurance)

- The Hard Stuff
- Higher Level of Criticality
- Airspace Procedural / Operational changes

Receive and Display Data (Advisory)

Initial Implementation

- Transmit only
- Ground Infrastructure Needed for Benefits

- 1090/UAT/VDL-Mode 4 (Transmit and Receive)
- Situational Awareness (visual acquisition)
- Surface and approach situational awareness
- CDTI Integration (Airborne, Surface, Moving Maps)

Transmit Data

- 1090MHz Squitter (Certified 2003)

Increasing Complexity



Avionics Prototypes: Parties Involved in the Recent Past

- **Who has been involved in moving the advanced surveillance technology prototype avionics forward**
 - **FAA**
 - **Safeflight-21 (with FAA Contractors)**
 - **NASA**
 - **CAA (UPS, FedEx, ...)**
 - **With FAA SF-21**
 - **FFRDCs (MITRE, MIT-LL)**
 - **RTCA**
 - **Eurocae**
 - **Manufacturers**
 - **European Union/European Commission**
 - **Eurocontrol and some European Airlines**

End user involvement has been low, with a few notable exceptions



Need for Certification – Top Down View

- **Customer demand**
 - **Depends on benefits**
 - **Efficiency benefits**
 - Depends on air traffic management changes
 - Procedure changes both for controllers and pilots
 - Change → uncertainty → viewed as undesirable unless known in detail
 - Details are starting to be developed
 - Procedure changes are being developed
 - **Safety benefits**
 - Benefit/cost is hard to demonstrate and depend on accident rates
 - Unfortunately latest and biggest accidents weigh heavily on mind of the public
- **The user driven development has happened only to a small extent so far**
 - **Current economic situation**
 - **Critical mass of transmitting aircraft is needed for benefits to accrue for those equipped with receivers (or TIS-B)**
 - **Benefits haven't been quantified to the point be everyone's satisfaction**
 - **Architectural issues**

Avionics certification is an expensive process



Need for Certification – Bottom Up View

- **Availability of industry standards (RTCA, AEEC, ICAO,...)**
 - **Certification baseline**
- **Experience – technical, functional and operational**
 - **Prototypes for risk reduction**
- **Architectures for the addressed market**
 - **Separation assurance vs. hazard system (integrity required)**
 - **Federated architecture**
 - **Integrated architecture**
 - **Functional**
 - **Logical**
 - **Other**
 - **Addressed market**
 - **Air Transport aircraft**
 - **Business aircraft**
 - **Regional Aircraft**
 - **Smaller G/A aircraft**

Need to be ready with new solutions when traffic rises again, but avionics development and certification are long lead time items



Architecture Issues

- **What is the right architecture for each *new* airplane**
 - Being addressed by airframe manufacturers (air transport, regional aircraft)
 - Being addressed by flight deck integrators (business aircraft, regional aircraft)
- **What is the right architecture for *existing* aircraft?**
 - What equipment/system to modify to incorporate the transmitter?
 - What equipment/system to modify to incorporate the receiver?
 - What equipment/system to modify to incorporate the processor?
 - How to modify the displays?
 - Technical issues on display modifications
 - Ownership issues on display modifications
 - Cost of modifications and recertification
 - What level of equipage is right at what timeframe?
 - Industry standards required for avionics integration
- **What provisions to make for future expansion?**
 - Data link decision from the FAA has somewhat simplified this issue



Status Overview

- Industry standards creation activity has been happening at a reasonably fast pace
- Prototypes have been developed and demonstrated
 - NASA
 - LVLASO (Focus: Airport surface operations – low visibility)
 - DFW (Focus: Airport surface operations - high precision)
 - Advanced Approach Spacing (Focus: Terminal area application)
 - FAA and CAA
 - OpEval-1 (Focus: RF link evaluation for ADS-B)
 - OpEval-2 (Focus: Evaluations of CDTI, Approach spacing, Departure spacing)
 - TESIS (Focus: Airport Surface Map, CDTI)
 - Other



Existing Prototypes

- Examples of prototypes
 - Transponder (ADS-B transmitter) [1090 MHz]
 - TCAS (ADS-B receiver) [1090 MHz]
 - 5ATI (Display)
 - 8" LCD (Display)
 - PC based processor (non-avionics, ADS-B received data processor)
 - PC based airport moving map display (Candidate for EFB)
- Examples of Certified products
 - Transponder (ADS-B Transmitter [1090 MHz])
 - Airframe manufacturers' initiative
 - Other (UAT, Displays, ...)

ADS-B Transmitter (Transponder)

Status:

Certified



ADS-B Receiver (TCAS)

Status:
Prototype



Generic CDTI (on 5" LCD Display)

Status:

Prototype



Airport Surface Moving Map (on 5" LCD Display)

Status:
Prototype



Advanced Approach Spacing Application (on 8" LCD Displays)

Approach Spacing
Engaged, 90 Sec
Interval

Range Ring -
Pilot Selectable,
Shown at 4.0 NM

Target A/C
Selected

Speed Cue Displayed on
PFD, Cyan Bug Indicates
Recommended Speed



Own Ship
Position

Selected Target A/C Data
Block - Includes Target
A/C Gnd Speed, Range,
Flight ID, A/C Type

Position Cue -
Indicates
Recommended
Position

Current Range Ring
Setting - 4.0 NM

Status:

Prototype

Rockwell
Collins

Airport Surface Moving Map on PC Display

Status:

Prototype

(Control Panel is
ad-hoc for
testing)





Plans for Future

- Solve architectural issues
 - Cooperative work for the industry, including airframe manufacturers and users
- ADS-B receiver [1090 MHz] (2004-2006)
- ADS-B processor (2004-2007)
- Displays new/modified (2004-2008)
- Airport surface moving maps with accurate database [object based database map] (2005-2008)
- Advanced surveillance applications for the flight deck (2004-2015)
 - Situational awareness (first)
 - Separation Assurance (later)
 - Issues

Timeframes are approximate



Summary

- Significant avionics prototyping has occurred and is occurring
 - Industry standards are becoming available
- User demand determines avionics certification
- Avionics certification is an expensive process with long lead times (esp. for higher levels of application criticality)
- Benefits for users depend on changes in airspace and the way airplanes currently operate in the airspace (e.g., procedure changes to take advantage of the aircrafts' performance)
 - Both new and existing aircraft need to be considered for equipage

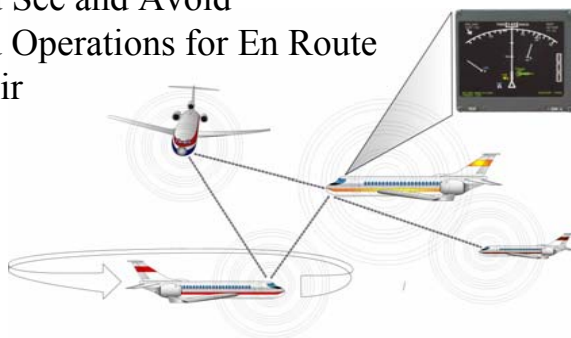


Backup Slides

Safe Flight 21 Overview: Nine Free Flight Enhancements

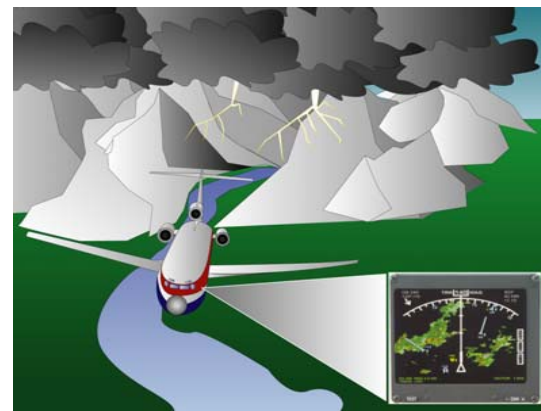
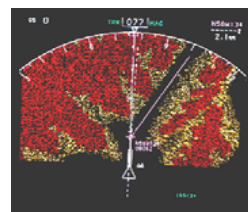
Air-to-Air

- Improved Separation Standards
- Improved Low-Visibility Approaches
- Enhanced See and Avoid
- Enhanced Operations for En Route Air-to-Air



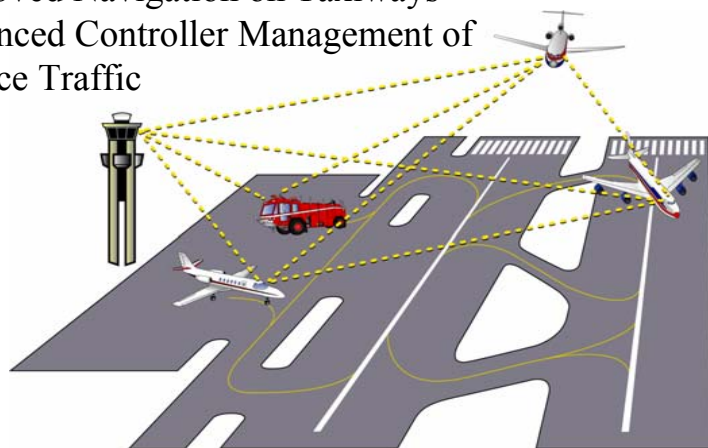
Air-to-Ground

- Surveillance Coverage in Non-Radar Airspace
- Affordable Reduction of Controlled Flight into Terrain (CFIT)



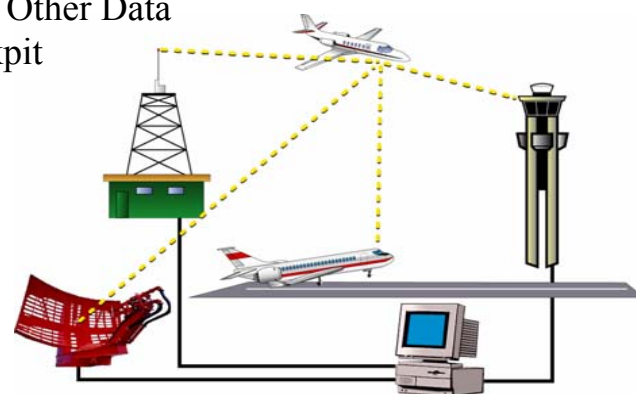
Ground-to-Ground

- Improved Navigation on Taxiways
- Enhanced Controller Management of Surface Traffic

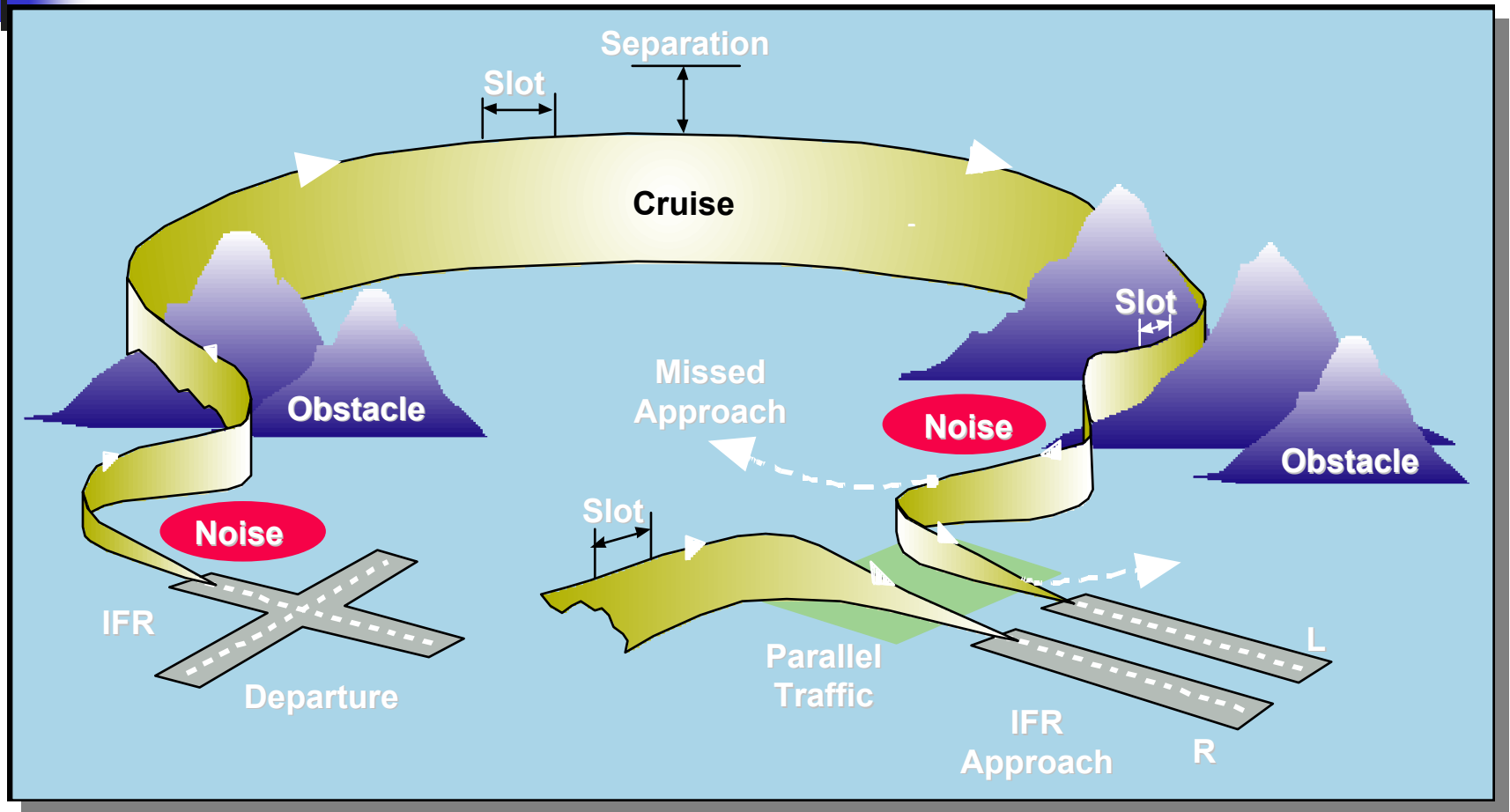


Ground-to-Air

- Weather and Other Data to the Cockpit

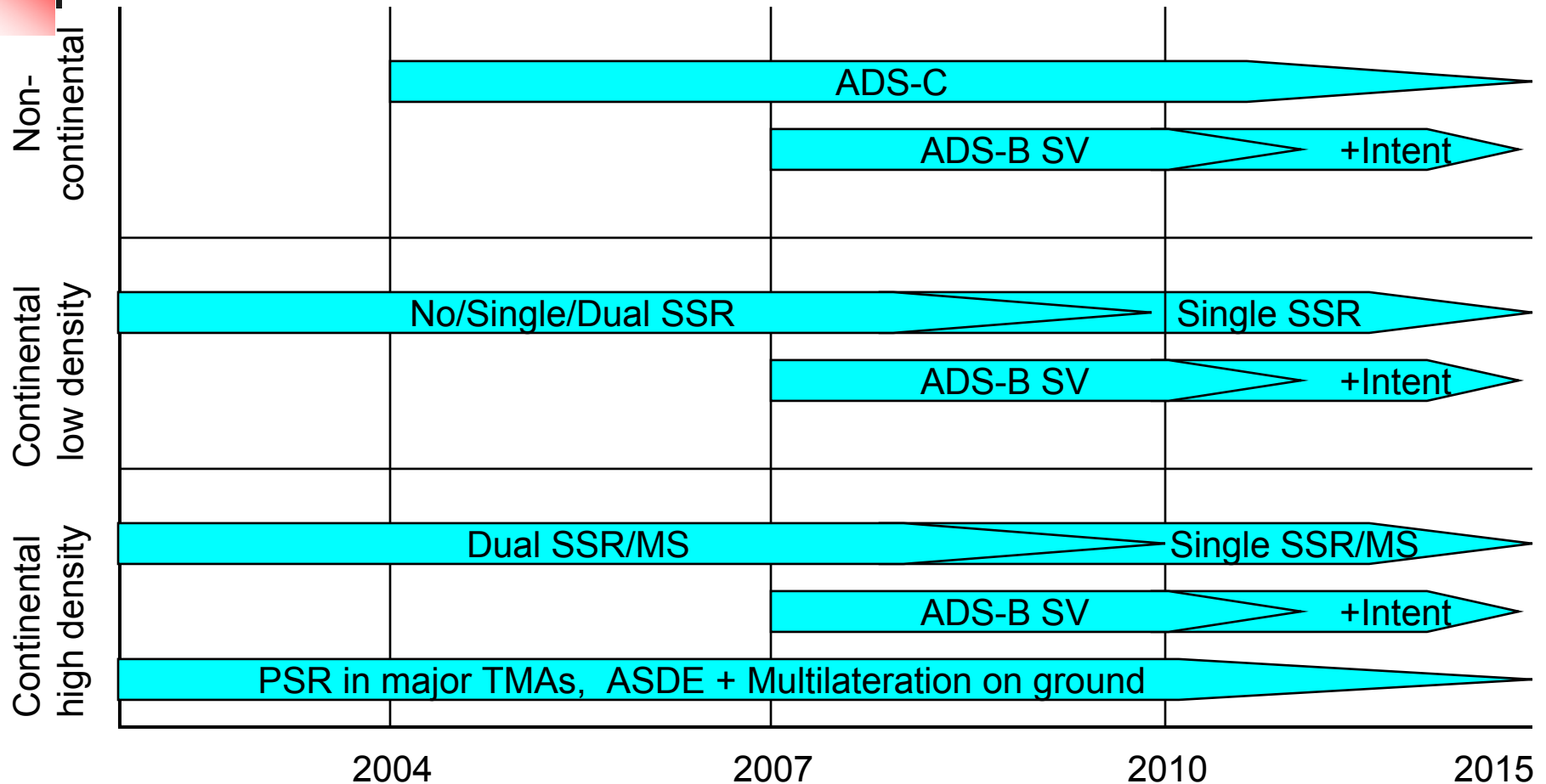


The Environment is Changing in all Phases of Flight

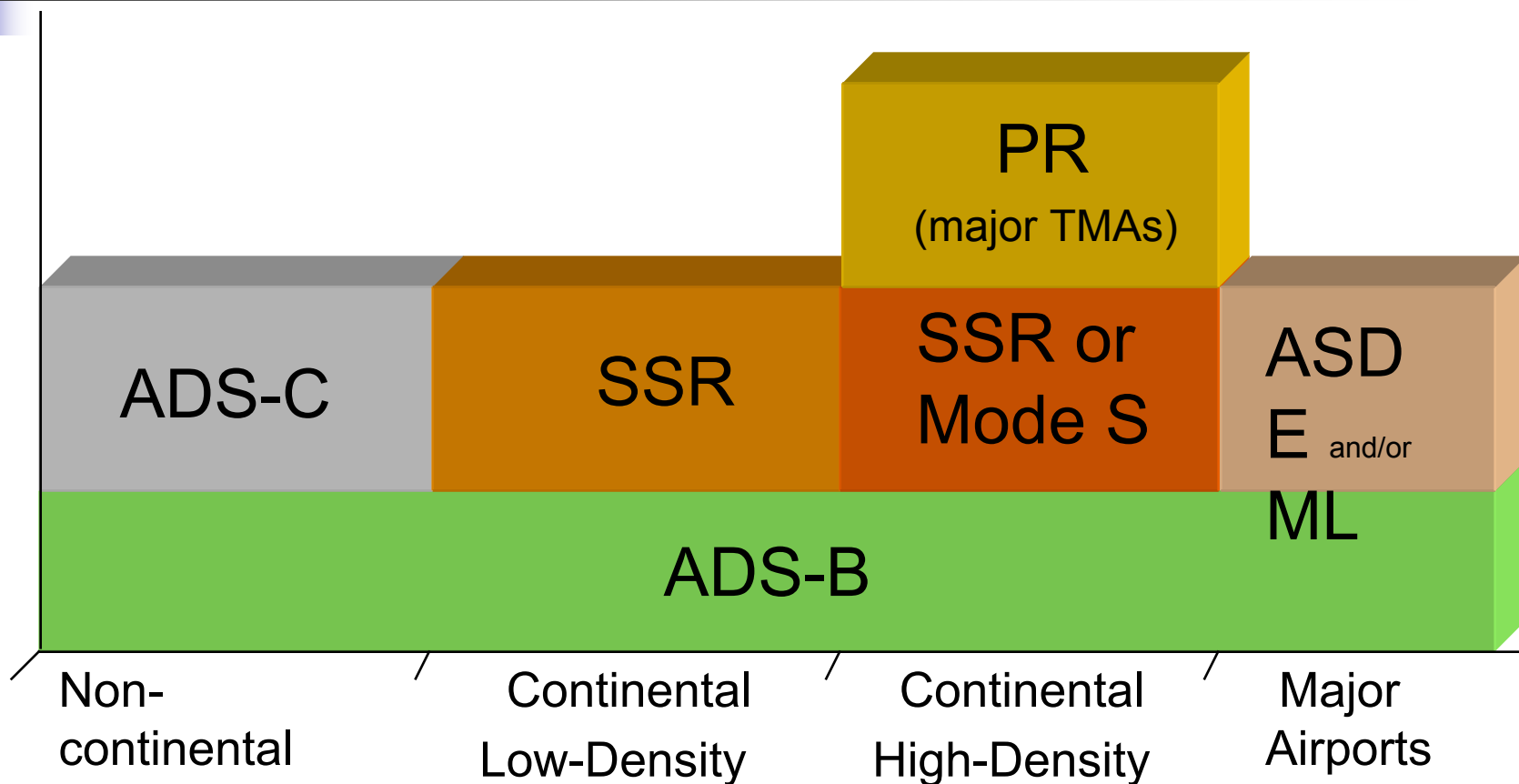


Domestic And International Impacts

ADS Transition Path (Europe)

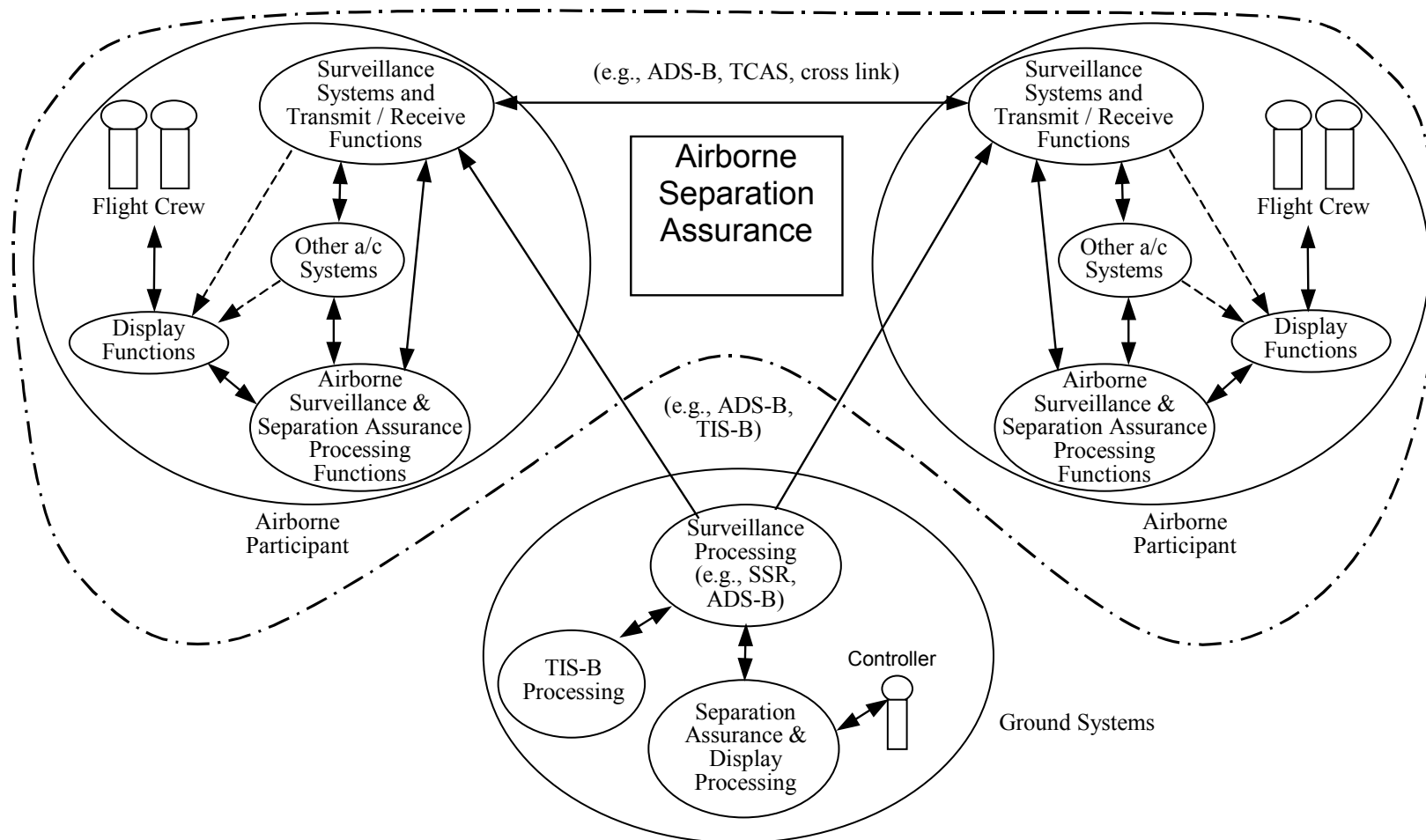


Proposed Target State - Europe (>2010)

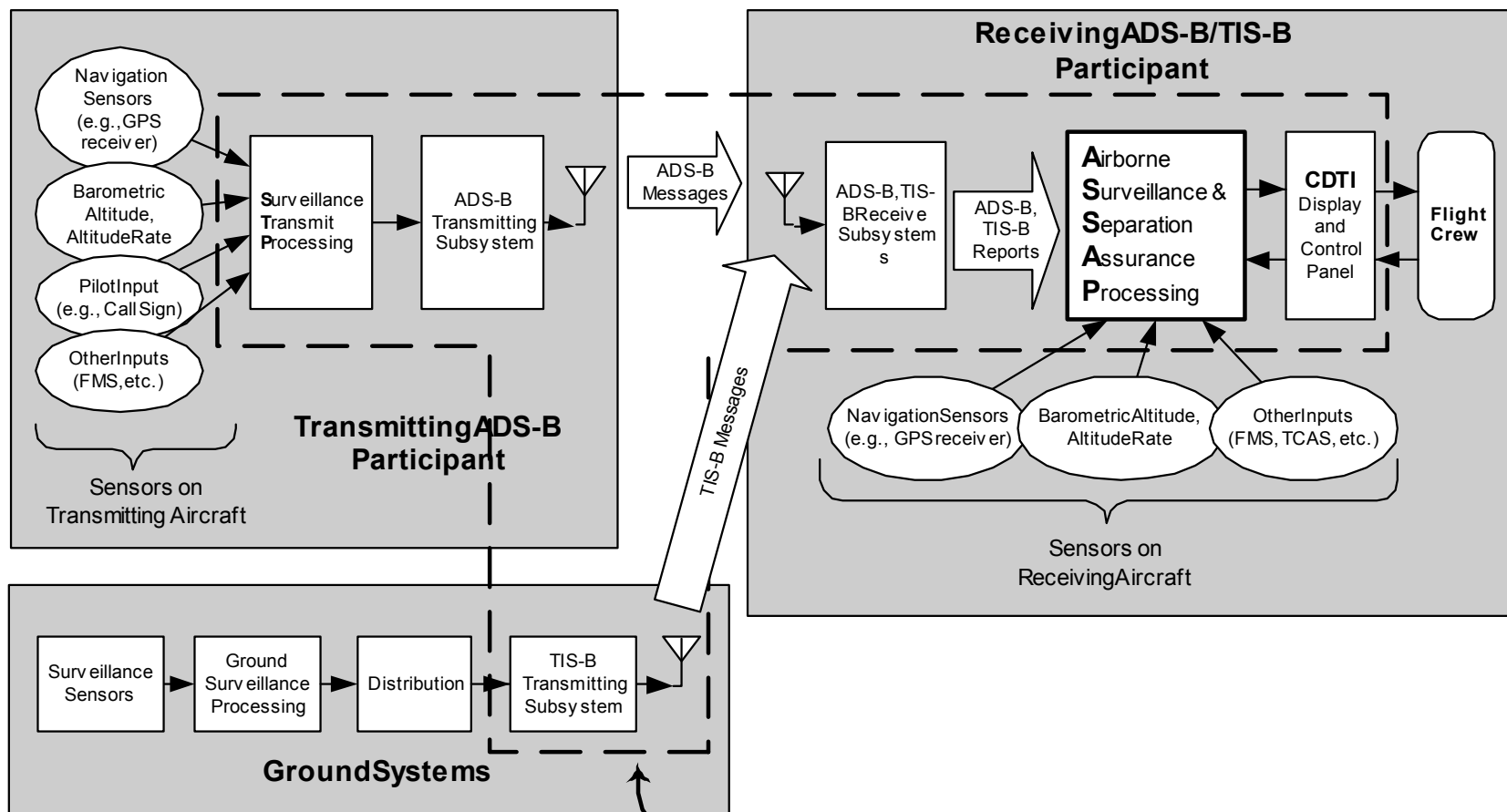


Note: Air-Air based surveillance will be based on ADS-B and TIS-B

Applications – Context



ASA System Boundary



Boundary of ASA System

RTCA SC-186 Document Hierarchy

